ANALYSING THE EFFECTS OF KNOWLEDGE ECONOMY EXTERNALITIES IN METROPOLITAN EMPLOYMENT GROWTH

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ABSTRACT

Large cities have some inherent urban and architectural attributes that make them attractive to the concentration of people and various economic activities, especially by the so-called knowledge economy sectors. They involve the transformation of talent and skills of workers, which require a constant spatial interaction. This means frequent face-to-face contacts. Agglomeration economies found in large cities are the determining factors behind knowledge economy growth, which in turn promotes the employment and residential density growth, as a whole. Hence, geographical proximity to the main urban centers of the metropolitan urban hierarchy becomes a causal factor for the growth and concentration of employment in these economy sectors. The aim of the research is to understand and model how knowledge economy externalities affect metropolitan employment density growth, and how the inter-municipal distances to the metropolitan core and the other largest metropolitan cities encourage that process. This phenomenology is studied in the metropolitan regions of Barcelona and Helsinki as follows: in Barcelona by modeling the density growth with employment data, inter-municipal distances and economic inter-linkages for the period 1991-2001; and in Helsinki by analyzing of employment pattern distributions with employment data for the period 2007-2010. Results suggest that the cities, especially the larger ones and their surrounding areas of both metropolitan regions, have a high value of knowledge economy activity concentrations due to the agglomeration economies found in them. Hence, the proximity to these large cities becomes the main factor that explains employment density growth and agglomeration patterns of the KIS employment.

KEYWORDS

Knowledge Economy; Urban Centrality; Geographical Proximity; Economic Diversity; Helsinki; Barcelona.

1. INTRODUCTION

In the last three decades of the twentieth century the cities and the metropolitan areas of industrialized economies experienced a considerable economic shift because of the mass industrialization and consolidation of services as the main source of their economic development (Graham and Marvin, 1996; Simmie, 2001, Harris, 2001). In this new scenario, the so-called knowledge intensive sectors (hereinafter KIS) that also include creative and cultural activities emerge as the main drivers of this process (Harris, 2001).

The KIS employment growth needs specialized knowledge, advanced technology and high skilled workers (OECD, 2001); innovation is a key driver for its advance. KIS activities involve transformation of individual talent and skills of workers; their growth requires constant social and spatial interaction.

Accessing to a codified knowledge that exists on the academic production and access to a tacit or uncoded knowledge found in people and in particular contexts occur primarily in urban centers, where both kind of knowledge are usually acquired by interactions among people (Simmie, 2001). However, transmission of both types of knowledge follows different patterns, while codified knowledge transmission can be carried out over long distances; tacit knowledge transmission requires spatial proximity and frequent face-to-face contacts (Polanyi, 1967; Leamer and Storper, 2001; Boschma and Lambooy, 2002; Storper and Venables, 2004). Geographical proximity arises as a key aspect to the KIS growth, since knowledge transmission is an essential process for the development of innovation.

In this paper the analysis about how physical proximity become a decisive factor for the location of the KIS employment in the core and in the sub centers of the metropolitan regions is analyzed. Agglomeration economies found in these areas, such as economy diversity, high skill workers and great accessibility to international markets and innovation products, are the determining factors that encourage that process. This phenomenology is studied in the Barcelona metropolitan region (hereinafter BMR), by modeling KIS density growth and; in the Helsinki metropolitan region (hereinafter HMR), by analyzing the KIS employment pattern distributions and employment decentralization processes. After this introduction, on the section two a theoretical framework about the relationship between proximity and knowledge economy growth is discussed; on the section three methodology and data uses is offered and; finally, on the section four the main results of the empirical analysis and conclusions are claimed.

2. URBAN CENTRALITY, AGGLOMERATION AND KNOWLEDGE ECONOMY

Knowledge economy refers to the economic production that since the last two decades of the 20th century arose in most of the post-industrial regions as a result of transformation of Fordism production towards the services, especially the knowledge-intensive services (Harris, 2001). Hence, despite the overall decentralization process of the employment, especially in manufactures from these regions to others with lower wages, employment growth in their labor markets remains due to a major specialization (Piore and Sabel, 1984).

Cities, especially those with a greater accessibility and high skill workers, are the urban centers where the big rates of the KIS employment are concentrated. It is happening because of the knowledge economy growth is based on existing knowledge and talent in people, as well as the knowledge that comes from their scientific practices and spatial interaction processes (Simmie, 2001; Varga, 2006; Lambooy, 2010). Schumpeter (1939) initially stated this role that territory has a force that encourage innovation process. He affirmed that demand push, which comes from the actors located in a territory are disseminators of knowledge, such as research centers, universities and small companies.

Post Fordism involved a reorganization of production systems, which is supported in small and medium sized companies that work through partnerships and a labor division between firms. This led to a greater interest in increasing investments in strengthening of human and social capital as well as the accumulation of technological and physical resources in most of the post-industrial regions (Clark, 1982; Lucas, 1988; Romer, 1994). This re-agglomeration of production led to extensive spatial changes in the regional area. Nowadays, firms tend to form clusters as a way to address the business processes of competition and cooperation (Scott, 1988, Porter, 1998). Globally, unique spaces would become in centers of extensive cluster of innovation, such as Silicon Valley and the region of Northern Italy as well as some cities of developed countries that nowadays are considered global cities due to the most important interchanges of knowledge that happen in them (Simmie, 2001, Hall, 2009, Taylor *et al*, 2010).

According to Storper and Venables (2004) face-to-face contacts that happen in the most of the post-industrial regions remain in the heart of the coordination of global economic growth. Two basic properties of face-to-face contacts are behind of that process: firstly, they provide efficient communication technology to the information that cannot be encoded; and secondly, they promote trusting relationships between different economic actors. These properties encourage the generation of environments where people interact and cooperate with other people to communicate ideas. Thus, geographic proximity becomes a determining factor for generation and transmission of knowledge either in a permanent colocation or in frequent face-to-face contacts between firms and workers.

Frequents face-to-face contacts and consequently a KIS employment growth are associated with the existence of agglomeration and localized specialized economic activities (Boschma and Lambooy, 2002). Therefore, acquisition of learning through this mechanism is an increasing function of city size and a related issue of a special urban hierarchy (Glaeser, 1999; Simmie, 2001; Sassen, 2011; Castells and Hall, 1994; Taylor *et al*, 2010). Big cities are the preferred locations for the large companies headquarters and their research units; besides, innovation products are mainly created in these kinds of cities and from them spread in a non-hierarchical relationship into the knowledge interchange nodes around the world. In other words, cities and urban regions that have a great centrality, due to their major accessibility, economic diversity, highly skilled workers and an environment that facilitates cooperation and constant innovation are the places where the KIS employment tends to be located (Graham and Marvin, 1996). Infrastructures found in these cities, as hub airports and high-speed trains highlight the importance that accessibility has to the local and global networks (Hall, 2009).

3. METHODOLOGY AND DATA

In the Barcelona case, I analyze how geographical proximity to the core and metropolitan sub centers encourage the employment density growth of KIS activities, as a consequence of the agglomeration economies for the KIS development found in those areas. Data used correspond to the employment data, inter-municipal distances and economic inter-linkages for the period 1991-2001 (data provided by the National Statistical Institute, INE). In the Helsinki case, I analyzed in a similar way as Barcelona, how agglomeration economies mainly found in the core of metropolitan region are affecting the clustering of KIS employment; in other words, I want to know how physical proximity to the core of the Region is affecting the agglomeration patterns of the KIS. Employment data for the period 2007-2010 was used in the analysis (data provided by the Statistical of Finland). Size of both metropolitan regions was an issue that was considered to the aggregation level analysis. Hence, the measure unit in the BMR was the municipal level; meanwhile in the HMR it was the sub district level.

3.1. Description of the Knowledge Economic Sectors Studied

Economic sectors studied are grouped in 8 sets according to their field of activity. This classification relates to the Organization for Economic Co-operation and Development classification for the whole economic sectors according to their use of high technology and large investments in R&D (OECD, 1999). These groups and their respective NACE 2008 codes are:

- Manufacture of computer, electronic and optical products (NACE code 26).
- ICT services (NACE codes 58, 59, 60, 61, 62 and 63):
- Business services related (NACE codes 69, 70, 71, 72, 73 and 74

- Financial services, including the insurance activities (NACE codes 64, 65 and 66)
- Cultural and creative activities (NACE codes 90 and 91):
- Real estate (NACE code 68)
- Education (NACE codes 72 and 85)
- Human health activities (NACE code 86)

These sectors in the BMR were clustering according to their final consumption in two kind of sectors, as follows: KIS, which final consumers are the government and homes (hereinafter KIS-GH) and; KIS, which final consumers are the enterprises (hereinafter KIS-E). In addition, from the rest of industries no KIS, I detailed which are the economy sectors with a high economic dependency (hereinafter KIS-REL). In order to do that, I made a multidimensional scaling analysis (MDS) with data about economic inter-linkages among all industries. These sectors are: printing and reproduction of recorded media; manufacture of chemical products; manufacture of basic pharmaceutical products; manufacture of electrical equipment; manufacture of furniture; water, electricity, gas, steam and air conditioning supply; construction of buildings and specialized construction activities; wholesale and retail trade; transporting and storage; accommodation; publishing activities and; rental and leasing activities.

3.2. The Barcelona and Helsinki Metropolitan Regions

Both metropolitan regions are important engines of their respective national economies and both highlight in their regional European context for their increasing employment specialization in KIS services and manufactures.

The BMR comprises 164 municipalities, being considered as the commuting area of Barcelona. Territory corresponds to the Metropolitan Territorial Plan, which was approved by the Regional Government on 2010. The BMR has a population of around 5 million people and 2 million of workplaces. It is the second largest urban agglomeration of the Spain and the largest Mediterranean metropolis. Despite that the Region has a polycentric configuration, Barcelona and its surrounding configuring the most important agglomeration of the whole region with around 60% of all its inhabitants. The service sectors dominate in the Region, specially business and financial.

The HMR comprises 12 municipalities; it has a population of 1,3 million of inhabitants and around 700.000 workplaces. Helsinki, Espoo and Vantaa are the three largest cities of the Region; they accumulate around 80% of whole population of the Region and 87% of its workplaces. These three cities integrated what is known as metropolitan area of Helsinki (hereinafter HMA). The service sectors dominate in the HMA, especially business and ICT; the manufacture sectors are basically specialized in electronics.

3.3. Delimiting of the main agglomerations of KIS employment

This process was done in both metropolitan areas by different ways, such as follow: in the BMR, at the level of the municipalities by delimiting the functional economy areas (hereinafter FEA) of the KIS sectors, which are distributed around of complementary sub centers to the CBD for the agglomeration of the KIS employment; and in the HMR, at the level of sub districts by detecting the sub districts that contain a high specialization in the KIS sectors and a remarkable employment density.

The delimitation of the FEA in the BMR was made modeling the monetary flows among all municipalities of the region; these flows give place to the economic areas in which the Region is structured. In order to do this, firstly, I analyzed the economic interdependences between the KIS and all economic sectors; secondly, I modeled economic flows with the information about workplaces existing by municipality and the information by commuting flows of workers by work reasons; finally, from these flows the FEA was created. In order to estimate theses areas I used the maximum interaction value technique of economical flows, which correspond to the main flows that exist among all municipalities of the Region; these flows are showing economic areas with high values of self-contention of economical activity and high levels of economic diversity.

In the HMR, the main KIS agglomerations were delimited through of a factorial and cluster K-means analysis. Factor analysis was made to find strong attributes from the areas where KIS employment is concentrated with data about the employment density, the percentage of KIS employment in each sub district, the specialization index by each KIS sector and the diversity economic index. Cluster analysis was made to find the main areas of the concentrations that factor analysis revealed; these areas match with the sub districts in which the Region is divided.

4. THE VALUE THAT GEOGRAPHICAL PROXIMITY HAS TO THE KIS EMPLOYMENT GROWTH IN THE METROPOLITAN REGIONS

Agglomeration economies found in the core of metropolitan regions and the sub centers are affecting KIS employment density growth. Hence, as will be demonstrate for both case studies, the physical proximity to the core and sub centers is a remarkable factor for the clustering process of the KIS employment.

4.1. Analyzing of the Metropolitan Core Distance Effects on the KIS Employment Density Growth (the BMR Case)

In the BMR decentralization process of the KIS employment from the largest urban agglomerations is mainly concentrated in the nearest suburbs to these large urban centers. The KIS are the economic sectors that are reluctant to leave their central locations because of the value that geographical proximity and access to skilled workers have for their performance. To analyze this phenomenon in detail, as explained in the methodology; firstly, I studied how was the change in the concentration of the KIS employment in the period 1991-2001 and; secondly, using a regression model, I evaluated which factors explain the KIS employment density and related economic sectors.

A conclusion of the decentralization process of the KIS employment in the BMR for the period 1991-2001 is the fact that this process has been mainly influenced by the geographical proximity to the metropolitan center and sub centers. As shown in the Table 1, a decentralization process of the KIS employment reveals a distinctly inertial tendency, especially in the case of the KIS for the companies' consumption; in contrast that happens with the rest of economic activities.

Table 1. Shift in the employment concentration 1991-2001. Source: own elaboration

Geographical area	(KIS-GH)	(KIS-E)	(KIS-REL)	Others
Core (Barcelona) and sub centers	-4,73	-6,65	-7,50	-6,38
Outskirts of Barcelona and sub centers	1,07	3,26	2,92	0,49
Other municipalities	3,66	3,39	4,57	5,89

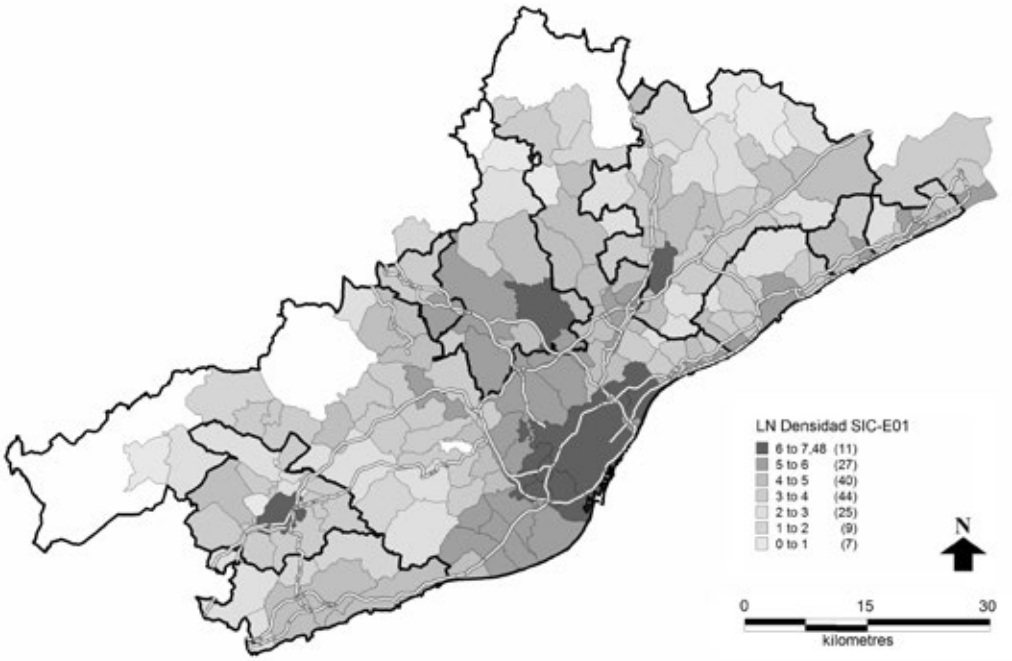
Gini index was applied in order to analyze the shift in the decentralization process of the KIS employment in the analyzed period. Results reveal a high employment concentration of the KIS. In addition, as show in the Table 2, the KIS employment decentralization on the temporal range studied was minor compared to what happened with the employment decentralization of other economic sectors.

Table 2. Gini index for the KIS and other economic sectors. Source: own elaboration

Industries	GINI-1991	GINI-2001	Shift GINI 2001-1991
KIS	0,90	0,88	-0,02
Others	0,87	0,83	-0,03

The distribution of the KIS employment density in the BMR reveals that the largest urban agglomerations and therefore the highest employment concentrations are the areas with the highest employment density values, as shown in the Figure 1. These areas have also high values of economic diversity. Hence, the economic diversity and the distance to the metropolitan core are the main explanatory variables of the KIS employment density in the Region, as it was verified in the regression analysis that is explained following.

Figure 1. KIS employment density BMR, 2001. Source: own elaboration



Regression model analysis revealed firstly, that the distance to Barcelona is the most determining factor, followed closely by the degree of economic diversity. Other explanatory variables have lower gradients; such as: existence of transport infrastructures (commuter train station and highway connection) and the percentage of land for economic activities (Table 3).

Table 3. Modeling of factors that affect the employment density of the KIS industries and related sectors in the BMR (2001). Source: own elaboration

Dependent Variable	R2	Explanatory variables		
		Name variables	Beta	Sig.
LN Density KIS-GH (WP/km^2)	0,58	β_1 (Distance to Barcelona)	-0,351	.000
		β_4 (Economic diversity index)	0,303	.000
		β_5 (Commuter train station)	0,296	.000
LN Density KIS-E (WP/km^2)	0,70	β_4 (Economic diversity index)	0.298	.000
		β_1 (Distance to Barcelona)	-0,268	.000
		β_5 (Commuter train station)	0,249	.000
		β_6 (Connection to motorway)	0,180	.004
		β_3 (% of land for economic uses)	0,109	.048
LN Density KIS-REL (WP/km^2)	0,55	β_4 (Economic diversity index)	0,335	.000
		β_5 (Commuter train station)	0,289	.000
		β_1 (Distance to Barcelona)	-0,210	.008
		β_3 % of land for economic uses)	0,145	.029

In the period 1991-2001 this reinforcement of the centrality of the agglomeration of Barcelona for the location of the KIS employment is verified when the changes in the gradients of the distances that are predicting the variations in the employment density of these economic sectors are analyzed. As seen in Table 4, the distance to Barcelona shows higher gradients over time.

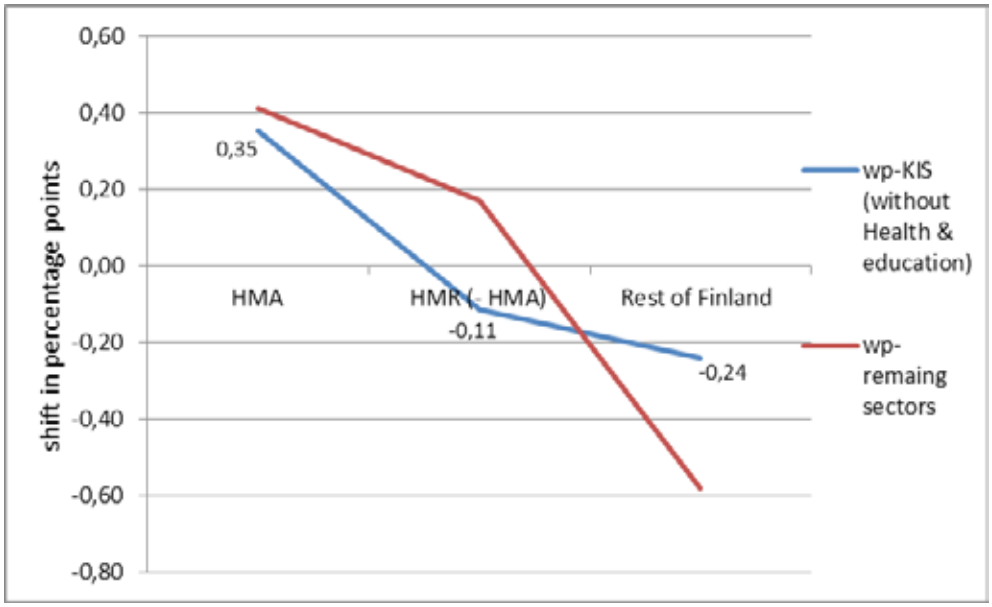
Table 4. Evolution of the gradients of the distance to Barcelona in the KIS employment density in the period 1991-2001. Source: own elaboration

KIS		1991		2001	
Beta		Sig.	Beta	Sig.	
ln-Dens_KIS-GH	dist_bcn	-0,251	,000	-0,351	,000
ln-Dens_KIS-E	dist_bcn	-0,217	,000	-0,268	,000
ln-Dens_KIS-REL	dist_bcn	-0,083	,206	-0,210	,008

4.2. Analyzing of the location patterns of KIS employment in the HMR

Analyzing the changes in the period 2007-2010 that coincides with the period of global economic recession highlights the importance that HMR, and specially the three largest cities of the HMA (Helsinki, Espoo and Vantaa) have for the location of the KIS employment. In the analyzed period there has not been a decentralization process from the HMA to the rest of the metropolitan Region and other places in Finland. In terms of competitive advantage it is still more profitable for firms to be situated in the HMA than elsewhere in Finland. As shown in the Figure 2, employment growth in KIS sectors in the HMA was 0.35 percentage points leaving out health and education since they do not have any specialization in the Region. In contrast, in the HMR and the rest of the country the KIS employment growth was negative.

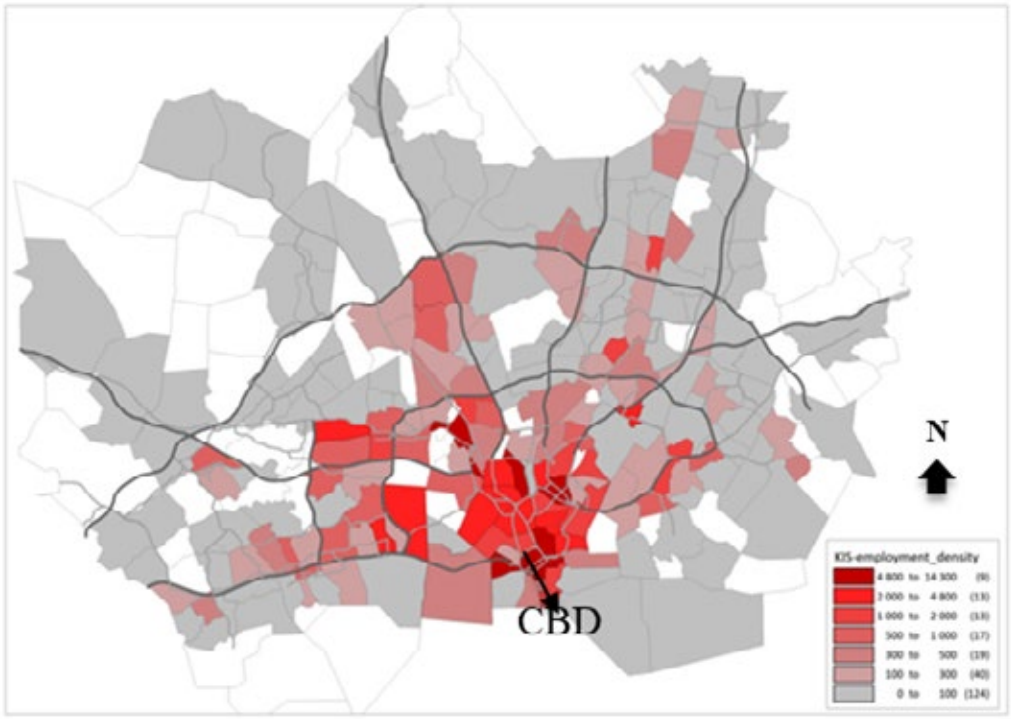
Figure 2. Shift in KIS employment, 2007-2010. Source: own elaboration.



In the HMA, Helsinki has the biggest share of the all KIS employment (70% of all KIS work places); it is followed by Espoo that has a share of 22% of all KIS employment and Vantaa, which has only 8% of all KIS. However, measuring employment share of the KIS sectors in the internal economic structure of each municipality reveals that Espoo has a clear specialization in these sectors; in this city, KIS accumulates 43% of its total work places, while in Helsinki it is 42%. In contrast, Vantaa remained the place less attractive to location of KIS employment in the HMA, despite the fact that the international airport is located there.

The analysis about the employment density of the KIS also stresses the value that the core of the HMR (center of Helsinki and its outskirts) has for the location of the KIS employment in the Region. As Figure 3 shows the biggest densities are located in the sub districts of the core of the Region.

Figure 3. KIS employment density, 2010. Source: own elaboration

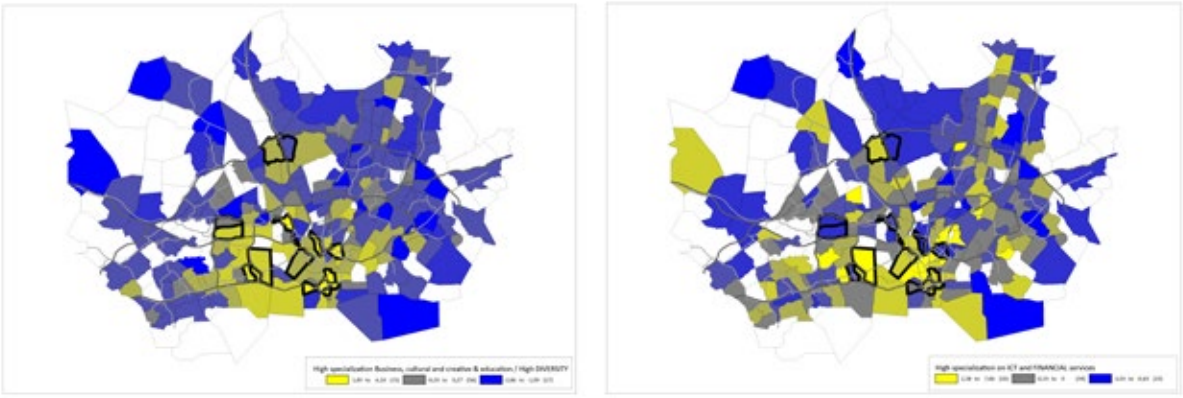


Using econometric tools (factorial and cluster analysis) from KIS employment data by each sub district, clusters that are strong concentration of the KIS employment in the HMA were identified. These clusters are revealing a hierarchical organization of all sub districts according to their size of the KIS employment, specialization index in each KIS industries, employment density and economic diversity. Two main clusters were identified. As show in the Figure 4, there is one cluster that is formed by sub district multi-specialized on KIS and a high economic diversity; it includes 12 sub districts, which are located mainly in the center of Helsinki and its outskirts. A second cluster is formed by sub districts mono-specialized on KIS and low economic diversity; they are situated mainly in no central locations of the HMA.

Figure 4. Principal KIS employment agglomerations, 2010. Source: own elaboration

Factorial analysis also reveals the role that central locations have as highly specialized areas for the KIS, such as: business, ICT and financial, which are the largest KIS industries of the Region. As shows in the Figures 5 and 6, employment specialization in these KIS industries is also highly related to the high values of economic diversity. This reinforces the importance that the agglomeration economies have for the economic specialization but also for the economy diversity found in the central locations of the metropolitan areas.

Figures 5 and 6. Factorials High specialization in Business, ICT and financial services and high economic diversity, 2010. Source: own elaboration



5. CONCLUSION

Cities are centers where converge people and various activities. It makes them suitable areas for the concentration of economic activities that requiring proximity and frequents exchange of information and knowledge. Therefore, the location patterns of the knowledge economy emphasize these proximity values found in cities.

This paper explains for the metropolitan regions of Barcelona and Helsinki the importance that proximity has to the largest urban centers for the location of the KIS employment and their related sectors. As noted, despite widespread decentralization processes of economic activity from the metropolitan centers, employment in these sectors have a remarkable inertia to leave the central locations. Peripheral locations to the metropolitan cores are being benefited by the agglomeration economies in them.

Analysis also revealed that there is a dependency relationship between the locative structure of KIS employment and the size of the labor market and the urban hierarchy of urban centers. In both metropolitan areas, the core is the most important area for the KIS employment location. Agglomeration economies associated to central locations are likely the factors that contributing to the KIS employment growth in them. This highlights the major advantages that the core has in terms of accessibility, proximity and concentration of people and various activities. Therefore, geographical proximity is a determinant factor of the KIS employment density in both metropolitan areas, as well as other issues such as the diversity of economic activity and certain specialization degreed.

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